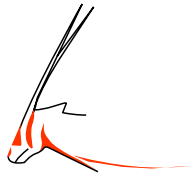
"ooRexx Tutorial"



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Agenda

- Brief History
- Rexx Basics
- Object Rexx
  - Some new features like
    - USE ARG
  - New: Directives
    - ::ROUTINE, ::REQUIRES
    - ::CLASS, ::ATTRIBUTE, ::METHOD
    - (::ANNOTATE, ::CONSTANT, ::OPTIONS, ::RESOURCE)
- Roundup

Some Historical Bits on Rexx

- Created for IBM mainframes to make programming easier compared to the rather awkward EXEC2
  - **Rexx design goals:** "human centric", "keep the language small", "easy to learn", "easy to understand hence easy to maintain"
  - Rexx is **still instrumental for IBM mainframe operating systems** today!
- Extremely successful in the 80'ies
  - Companies selling Rexx interpreters successfully, **ANSI/INCITS standard** (!)
- Object-oriented successor ("Object Rexx") in the 90'ies
  - **Open-sourced** in 2005 by RexxLA.org – "open object Rexx" (ooRexx)
    - Available for **all major operating systems**
    - Possible to programme even MS Windows applications via OLE ...

Fundamental Rexx Concepts, 1

- "Everything is a string"
  - If a string represents a number, one can carry out arithmetic
- Three instruction types
  1) Assignment
     - Variable name followed by the assignment operator (=) and an expression
  2) Keyword instruction
     - Keywords are English words conveying the intent of the keyword instruction, e.g. SAY, DO, IF, LOOP, CALL, PARSE, SELECT, ITERATE, LEAVE, INTERPRET, ...
     - Makes Rexx code legible as if it was pseudocode
  3) Commands
     - A string passed to the operating system for execution (as if typed in a window)

Fundamental Rexx Concepts, 2

- White space can be freely used to format code for better legibility
  - Space around operators gets removed
  - White space between symbols will be reduced to a single space serving as concatenation operator
  - Hence indentations with white space not significant
- Case of symbols irrelevant
  - Rexx uppercases everything outside of quoted strings
  - No (frustrating) casing errors for novices

```
sum = 17 +   19
      hint   =    "/ 17+19:"      sum
  say   hint  "/"    upper( "aü ß äöü ÄÖÜ A/ ? \\--// :-)"   )
```

```
SUM=17+19
HINT="/ 17+19:" SUM
SAY HINT "/" UPPER("aü ß äöü ÄÖÜ A/ ? \\--// :-)")
```

Output:

```
/ 17+19: 36 / Aü ß äöü ÄÖÜ A/ ? \\--// :-)
```

Fundamental Rexx Concepts, 3

- Rexx nutshell examples to stress fundamental concepts
  - Illustrate the Rexx language
    - Code intuitive and easy understandable as it looks like pseudo code
  - Same examples in the popular Python language to allow direct comparisons
    - Cannot be understood without an introduction to many concepts of the Python language

Instructions


```
    /* an assignment instruction:      */
a="hello world"   /* assigns "hello world" to a variable named a  */

    /* a keyword instruction:          */
say a             /* output: hello world */

    /* a command instruction:          */
    /* a command (could be typed into a command line window)          */
"echo Hello World 2" /* execute command                               */
   /* variable RC contains the command's return code, 0 means success */
if rc=0 then say "success!"
        else say "some problem occurred, rc="rc /* show return code   */
```

Output:

```
hello world
Hello World 2
Success!
```


```
# an assignment instruction
a="hello world"     # assigns "hello world" to a variable named a

# no keyword instruction for output, using built-in function print()
print(a)

# no command instruction using module subprocess instead
import subprocess   # import subprocess module
# execute command
completedProcess=subprocess.run("echo Hello World 2", shell=True) # run
rc=completedProcess.returncode  # fetch return code, an int
if rc==0:
    print("found!") # indentation mandatory (forcing a block)
else: # must use + (concatenation operator) with str() function
    print("some problem occurred, rc="+str(rc)) # turn rc into a string
```

Output:

```
hello world
Hello World 2
Success!
```

Nutshell Example, 2

Blocks, Selection, Multiple Selections

```
max=5             /* number of repetitions   */
loop a=1 to max   /* loop block              */
   select         /* nested block # 1        */
      when a=1 then say a": first round"
      when a=2 then say a": second round"
      when a=3 then say a": third round"
      otherwise say "(a="a")"
   end

   if a=max then
   do             /* nested block # 2        */
      say "-> a=max"
      say "-> last round!"
      say "-> loop will end"
   end
end
```

Output:

```
1: first round
2: second round
3: third round
(a=4)
(a=5)
-> a=max
-> last round!
-> loop will end
```

```
max=5       # number of repetitions
for a in range(1,max+1): # loop with range() function, must add 1 to max
            # must use str() function with + (concatenation operator)
    match a:    # must be indented, "match" needs Python 3.10 or higher
        case 1: print(str(a)+": first round")   # nested block # 1
        case 2: print(str(a)+": second round")  # nested block # 1
        case 3: print(str(a)+": third round")   # nested block # 1
        case _: print("(a="+str(a)+")")  # default, nested block # 1

    if a==max:  # must be indented, must use == instead of =
        print("-> a==max")          # nested block # 2
        print("-> last round!")     # nested block # 2
        print("-> loop will end")   # nested block # 2
```

Output:

```
1: first round
2: second round
3: third round
(a=4)
(a=5)
-> a==max
-> last round!
-> loop will end
```


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Nutshell Example, 3

Parsing Strings

```
text = " John     Doe   Vienna Austria"
parse var text firstName lastName city country
say "first name:" firstName", last name:" lastName", city:" city
```

```
text = "Mary Doe Tokyo Japan"
parse var text firstName lastName city .   /* ignore country */
say "first name:" firstName", last name:" lastName", city:" city
```

Output:

```
first name: John, last name: Doe, city: Vienna
first name: Mary, last name: Doe, city: Tokyo
```

```
text      = " John     Doe   Vienna Austria"
words     = text.split()    # create list of words
firstName = words[0]        # assign to variable
lastName  = words[1]        # assign to variable
city      = words[2]        # assign to variable
print("first name:",firstName+",","last name:",lastName+",","city:",city)
```

```
text  = "Mary Doe Tokyo Japan"
words = text.split()    # create list of words
# assign multiple elements in a single statement
firstName, lastName, city = [words[i] for i in (0, 1, 2)]
print("first name:",firstName+",","last name:",lastName+",","city:",city)
```

Output:

```
first name: John, last name: Doe, city: Vienna
first name: Mary, last name: Doe, city: Tokyo
```

ooRexx: Some New Features

- Compatible with classic Rexx, TRL 2
  - New sequence of execution of Rexx programs:

    Phase **1** (**load**): Full syntax check of the Rexx program upfront

    Phase **2** (**setup**): Interpreter carries out all directives (lead in with "**::**")

    Phase **3** (**execution**): Start of program execution with line # 1
- rexxc[.exe]: compiles Rexx programs
  - If *same bitness* and *same endianness*, on *all* platforms
- USE ARG (in addition to PARSE ARG)
  - among other things allows for retrieving stems *by reference (!)*
- Line comments, led in by two dashes ("**--**")

  -- comment until the line ends

Stem, Classic REXX

"stemclassic.rex"

```
s.1="Entry # 1"
s.2="Entry # 2"
s.0=2          /* total number of entries in stem           */

call add2stem  /* add to stem using an (internal) routine   */

do i=1 to s.0  /* iterate over all stem array entries       */
   say "#" i":" s.i
end
exit

add2stem: procedure expose s. -- allow access to stem
  n=s.0+1      /* add after last current entry              */
  s.n="Entry #" n "added in add2stem()"
  s.0=n        /* update total number of entries in stem    */
  return

/* yields:

   # 1: Entry # 1
   # 2: Entry # 2
   # 3: Entry # 3 added in add2stem()

*/
```

Stem, REXX with USE ARG

"stemusearg.rex": *No EXPOSE*

```
s.1="Entry # 1"
s.2="Entry # 2"
s.0=2              /* total number of entries in stem           */

call add2stem s.   /* supply stem as an argument!               */

do i=1 to s.0      /* iterate over all stem array entries       */
   say "#" i":" s.i
end
exit

add2stem: procedure  /* no "expose s." needed anymore !         */
  use arg s.     /* USE ARG allows to directly refer to the stem */
  n=s.0+1        /* add after last current entry                */
  s.n="Entry #" n "added in add2stem()"
  s.0=n          /* update total number of entries in stem      */
  return

/* yields:

   # 1: Entry # 1
   # 2: Entry # 2
   # 3: Entry # 3 added in add2stem()

*/
```

Stem, ooRexx USE ARG

"stemroutine1.rex": *No EXPOSE*

```
s.1="Entry # 1"
s.2="Entry # 2"
s.0=2              /* total number of entries in stem           */

call add2stem s.   /* supply stem as an argument!               */

do i=1 to s.0      /* iterate over all stem array entries       */
   say "#" i":" s.i
end

::routine add2stem
  use arg s.    /* USE ARG allows to directly refer to the stem */
  n=s.0+1       /* add after last current entry                 */
  s.n="Entry #" n "added in add2stem()"
  s.0=n         /* update total number of entries in stem       */
  return

/* yields:

   # 1: Entry # 1
   # 2: Entry # 2
   # 3: Entry # 3 added in add2stem()

*/
```

Stem, ooRexx USE ARG

"stemroutine2.rex": *No EXPOSE*

```
s.1="Entry # 1"
s.2="Entry # 2"
s.0=2              /* total number of entries in stem           */

call add2stem s.   /* supply stem as an argument!               */

do i=1 to s.0      /* iterate over all stem array entries       */
   say "#" i":" s.i
end

::routine add2stem   /* we can even use a different stem name  */
  use arg abc. /* USE ARG allows to directly refer to the stem */
  n=abc.0+1    /* add after last current entry                 */
  abc.n="Entry #" n "added in add2stem()"
  abc.0=n      /* update total number of entries in stem       */
  return

/* yields:

   # 1: Entry # 1
   # 2: Entry # 2
   # 3: Entry # 3 added in add2stem()

*/
```

About Directives in ooRexx

- Always placed at the end of a Rexx program
  - led in by "**::**" followed by the name of the directive
    - "routine", "class", "attribute", "method", ...
- Instructions to the ooRexx interpreter before program starts
  - Interpreter sequentially processes and carries out directives in the ***setup*** *phase* (phase **2**) of startup
  - After all directives got carried out, the *execution phase of the Rexx program* starts by executing the first line
- An ooRexx program with directives
  - Defines a "package" of routines and classes
  - Rexx code before the first directive is also named "prolog"

::Routine Directive

- Syntax

  ::routine name [public]

  – Interpreter maintains routines (and classes) per Rexx program ("package")

  – If optional keyword public is present, the routine can be also ***directly*** *invoked by another (!) Rexx program*

::ROUTINE Directive, Example "routine.rex"

```
r=" 1 "
s=2
say "r="pp(r)
say "s="pp(s)
say
say "The result of 'r || 3 ' is:" pp(r || 3 )
say "The result of 's || 3 ' is:" pp(s || 3 )
say "The result of 'r + 3'   is:" pp(r +  3)
say "The result of 's + 3'   is:" pp(s +  3)
say
say "The result of 'r s'     is:" pp(r s)
say "The result of 'r || s'  is:" pp(r || s)
say "The result of 'r+s'     is:" pp(r+s)

::routine pp              -- enclose argument in square brackets
  parse arg value
  return "["value"]"

/* yields:

   r=[ 1 ]
   s=[2]

   The result of 'r || 3 ' is: [ 1 3]
   The result of 's || 3 ' is: [23]
   The result of 'r + 3'   is: [4]
   The result of 's + 3'   is: [5]

   The result of 'r s'     is: [ 1  2]
   The result of 'r || s'  is: [ 1 2]
   The result of 'r+s'     is: [3]
*/
```

::ROUTINE Directive, Example "toolpackage.rex"

```
-- collection of useful little Rexx routines

::routine pp public -- enclose argument in square brackets
   parse arg value
   return "["value"]"

::routine quote public -- enclose argument in double-quotes
   parse arg value
   return '"' || value || '"'
```

::ROUTINE Directive, Example "call_package.rex"

```
call toolpackage.rex   -- get access to public routines in "toolpackage.rex"
say quote('hello, my beloved world')

r=" 1 "
s=2
say "r="pp(r)
say "s="pp(s)
say
say "r="quote(r)
say "s="quote(s)
say
say "The result of 'r || 3 ' is:" pp(r || 3 )
say "The result of 's || 3 ' is:" quote(s || 3 )
say "The result of 'r + 3'   is:" pp(r +  3)
say "The result of 's + 3'   is:" quote(s +  3)

/* yields:

   "hello, my beloved world"
   r=[ 1 ]
   s=[2]

   r=" 1 "
   s="2"

   The result of 'r || 3 ' is: [ 1 3]
   The result of 's || 3 ' is: "23"
   The result of 'r + 3'   is: [4]
   The result of 's + 3'   is: "5"
*/
```

::REQUIRES Directive

- Syntax

  ::requires "package.rex"

  – Interpreter in (setup) phase 2 will either

    - Call (execute) the Rexx program in the file named "package.rex" on behalf of the current Rexx program and make all its public routines and classes upon return directly available to us
    - *Or* if the interpreter already has *required* that "package.rex" it will *immediately* make all its public routines and classes available to us
      – In this case "package.rex" will ***not*** *be called (executed) anymore!*

::REQUIRES-Directive, Example "requires_package.rex"

```
say quote('hello, my beloved world')

r=" 1 "
s=2
say "r="pp(r)
say "s="pp(s)
say
say "r="quote(r)
say "s="quote(s)
say
say "The result of 'r || 3 ' is:" pp(r || 3 )
say "The result of 's || 3 ' is:" quote(s || 3 )
say "The result of 'r + 3'   is:" pp(r +  3)
say "The result of 's + 3'   is:" quote(s +  3)

::requires toolpackage.rex -- get access to public routines in "toolpackage.rex"

/* yields:

   "hello, my beloved world"
   r=[ 1 ]
   s=[2]

   r=" 1 "
   s="2"

   The result of 'r || 3 ' is: [ 1 3]
   The result of 's || 3 ' is: "23"
   The result of 'r + 3'   is: [4]
   The result of 's + 3'   is: "5"
*/
```

The Message Paradigm, 1

- A programmer sends messages to objects
  - The *object* looks for a method routine with the same name as the received message
  - If arguments were sent the *object* forwards them
  - The *object* returns any value the method routine returns
- *C.f. <https://en.wikipedia.org/wiki/Alan_Kay>*
  - One of the fathers of Smalltalk's "object-orientation"
- Programming languages with this paradigm, e.g.
  - Smalltalk, Objective C, ...

The Message Paradigm, 2

ooRexx

- Proper message operator "~" (tilde, "twiddle")
- In ooRexx everything is an *"object"*
  - Hence one can send messages to everything!
- Example

```
say "hi, Rexx!"~reverse

-- same as in classic REXX:

say reverse("hi, Rexx!")

-- both yield (actually run the same code):
!xxeR ,ih
```

The Message Paradigm, 3

ooRexx

- Creating "*values*" a.k.a. "*objects*", "*instances*"

  Classic Rexx-style (strings only)

  ```
  str="this is a string"
  ```

  ooRexx-style (*any* class/type including .string class)

  ```
  str=.string~new("this is a string")
  ```

About Classic REXX Structures, 1

Important Usage of Stems

- Whenever structures ("records") are needed, *stems* get used in classic REXX
- Example
  - A person may have a name and a salary, e.g.

    p.name = "Doe, John"

    p.salary= "10500"
  - E.g. a collection of data with a person structure

    p.1.name = "Doe, John"; p.1.salary=10500

    p.2.name = "Doe, Mary"; p.2.salary=8500

    p.0 = 2

About Classic REXX Structures, 2

Important Usage of Stems

- Whenever *structures* ("*records*") need to be processed, *every* Rexx programmer *must* know the *exact stem encoding!*
- *Everyone* must implement routines like increasing the salary *exactly* like everyone else!
- If *structures* are simple and not used in many places, this is o.k., but the more complex the more places the *structure* needs to be accessed, the more error prone this becomes!

About ooREXX *Structures*, 1

Classes (Types, Structures)

- Any object-oriented language makes it easy to define and implement *structures*!
  - That is what they were designed for!
- The *structure* ("*class*", "*type*") usually consists of
  - *Attributes* (data elements like "name", "salary"), a.k.a. "*object variables*", "*fields*", ...
  - *Method* routines (like "increaseSalary")

About ooREXX *Structures*, 2

Classes (Types, Structures)

- **::CLASS** Directive
  - Denotes the name of the *structure*
  - Can optionally be public
- **::ATTRIBUTE** Directive
  - Denotes the name of a *data element*, *field*
- **::METHOD** Directive
  - Denotes the name of a routine of the *structure*
  - Defines the *Rexx code* to be run, when invoked

About ooREXX *Structures*, 3

Classes (Types, Structures)

- Once
  - A *structure* ("*class*", "*type*" both of which are synonyms of each other) got defined
  - One can create an *unlimited (!) number* of persons ("*instances*", "*objects*", "*values*", all of which are synonyms)
    - *Each* person will have its *own copy of attributes (data elements, fields)*
    - *All* persons will share/use the *same method routines* that got defined for the structure (class, type)

ooRexx Structure "Person"

"personstructure.rex"

```
p=.person~new("Doe, John", 10500)
say "name:  " p~name
say "salary:" p~salary

::class person              -- define the name

::attribute name            -- define a data element, field, object variable
::attribute salary          -- define a data element, field, object variable

::method    init            -- constructor method routine (to set the attribute values)
  expose name salary        -- establish direct access to attributes
  use arg name, salary      -- fetch and assign attribute values

/* yields:

   name:   Doe, John
   salary: 10500

*/
```

Defining the ooRexx Class (Type) "person.cls"

```
::class person PUBLIC    -- define the name, this time PUBLIC

::attribute name         -- define a data element, field, object variable
::attribute salary       -- define a data element, field, object variable

::method    init         -- constructor method routine (to set the attribute values)
  expose name salary     -- establish direct access to attributes
  use arg name, salary   -- fetch and assign attribute values
```

Defining the ooRexx Class (Type) "requires_person.rex"

```
p.1 = .person~new("Doe, John", 10500)
p.2 = .person~new("Doe, Mary",  8500)
p.0 = 2

sum=0
do i=1 to p.0
   say p.i~name "earns:" p.i~salary
   sum=sum+p.i~salary
end
say
say "Sum of salaries:" sum

::requires person.cls    -- get access to the public class "person" in "person.cls"

/* yields:

   Doe, John earns: 10500
   Doe, Mary earns: 8500

   Sum of salaries: 19000
*/
```

ooRexx *Classes* and Beyond ...

- ooRexx comes with a wealth of *classes*
  - A lot of tested functionality for "free" ;-)
  - E.g., the collection classes augment what stems are capable of doing!
    - Explore the collection classes and you will immediately be much more productive!
    - If seeking arrays, you have them: .Array class
  - Consult the pdf-books coming with ooRexx, e.g.,
    - "ooRexx Programming Guide" (rexxpg.pdf)
    - "ooRexx Reference" (rexxref.pdf)

Roundup

- ooRexx is great and compatible to classic REXX
  - You can continue to program in classic REXX, yet use ooRexx on Linux, MacOS, Windows, s390x...
- ooRexx adds a lot of flexibility and power to the REXX language and to your fingertips
  - One can take advantage of all of it immediately
  - Simple to use because of the *message paradigm*
    - Send ooRexx *messages* to Windows and MS Office ...
    - Send ooRexx *messages* to Java ...
    - Send ooRexx *messages* to ...
- ***Get it and have fun! :-)***

Links

- RexxLA-Homepage (non-profit SIG, owner of ooRexx, BSF4ooRexx)
  <http://www.rexxla.org/>
- OoRexx 5.1.0 on Sourceforge
  <https://sourceforge.net/projects/oorexx/files/oorexx/5.1.0/>
  - Introduction to ooRexx on Windows, Slides ("Business Programming 1")
    - <http://wi.wu.ac.at/rgf/wu/lehre/autowin/material/foils/>
- BSF4ooRexx850 on Sourceforge (ooRexx-Java bridge)
  <https://sourceforge.net/projects/bsf4oorexx/>
  - Introduction to BSF4ooRexx (Windows, Mac, Unix), Slides ("Business Programming 2")
    - <http://wi.wu.ac.at/rgf/wu/lehre/autojava/material/foils/>
- Student's work, including ooRexx, BSF4ooRexx
  <http://wi.wu.ac.at/rgf/diplomarbeiten/>
- JetBrains "IntelliJ IDEA", powerful IDE for all operating systems
  - <https://www.jetbrains.com/idea/download>, free "Community-Edition"
    - Students and lecturers can use the professional edition for free
  - Alexander Seik's ooRexx-Plugin with readme (as of: 2025-05-07)
    - <https://sourceforge.net/projects/bsf4oorexx/files/Sandbox/aseik/ooRexxIDEA/GA/2.5.0/>
- "Introduction to Rexx and ooRexx" (254 pages, covers ooRexx 4.2)
  Google et.al., or, <https://www.facultas.at>